MEMORANDUM

TO: Docket

FROM: EPA, Clean Air Markets Division

SUBJECT: Integrated Planning Model (IPM) Runs used in Developing the Proposed Interstate Air Quality Rule (IAQR) Emission Reduction and Cost-effectiveness Estimates

DATE: January 28, 2004

EPA uses the Integrated Planning Model (IPM) to examine costs and, more broadly, analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous States and the District of Columbia. The IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. The National Electric Energy Data System (NEEDS) contains the generation unit records used to construct model plants that represent existing and planned/committed units in EPA modeling applications of IPM. The NEEDS 2003 includes basic geographic, operating, air emissions, and other data on all the generation units that are represented by model plant in EPA's version 2.1.6 update of IPM. IPM documentation and the NEEDS database are available in the IAQR docket and also on EPA's website at www.epa.gov/airmarkets/epa-ipm/.

We used IPM version 2.1.6 to analyze cost and emissions impacts of the proposed IAQR. This memo describes the IPM runs that we used. Model output from each of the IPM runs listed in this memo is available in the IAQR docket and also on EPA's website at www.epa.gov/airmarkets/epa-ipm/.

Modeling applications of IPM produce forecasts for model plants, i.e., clusters of real life electricity generating units with similar characteristics. The model plant projections can be used to produce parsed results, which are unit-level results derived from the model plant projections. Projections for individual plants are based on data currently available and modeling parameters which are simplifications of the real world. It is likely that some future actions regarding individual plants could differ from model projections of actions; however, the aggregate impacts are expected to be appropriately characterized by the model. Where appropriate, EPA produced parsed results from IPM runs for use in analyzing the proposed IAQR.

IPM Run ID: EPA216_ a9c
Descriptive Title: EPA Base Case for 2003 Analyses
This is the Base Case model run (the same Base Case that we used for Clear Skies Act analyses). The Base Case includes the national Title IV SO2 cap and trade program, NOx SIP Call regional ozone season cap and trade program, and State-specific programs in Connecticut, Massachusetts, Missouri, New Hampshire, North Carolina, Texas, and Wisconsin. This run represents conditions without the proposed IAQR. EPA used the Base Case run to compare costs and emissions to the proposed IAQR. We also used parsed results from the Base Case run, for model years 2010 and 2015, in order to analyze State-level effects of the proposal. IPM Run ID and descriptive titles for the parsed Base Case runs are as follows:

IPM Run ID: EPA216a9c_2010_parsed
Descriptive Title: EPA Base Case 2003 parsed for year 2010

IPM Run ID: EPA216a9c_2015_parsed
Descriptive Title: EPA Base Case 2003 parsed for year 2015

IPM Run ID: EPA216_IAQR_2003
Descriptive Title: Proposed IAQR Case
This model run represents the proposed IAQR control strategy. The proposed strategy would require SO2 caps of 3.9 million tons in 2010 and 2.7 million tons in 2015, in 28 States and the District of Columbia in the eastern part of the country. The strategy would require annual NOx caps of 1.6 million tons in 2010 and 1.3 million tons in 2015 in the same geographic region as the SO2 caps, and in addition would require ozone season NOx reductions in Connecticut.

The IPM analysis was begun before EPA made final determination regarding the States affected by the proposed IAQR. Thus we performed IPM analysis on slightly different control regions than the region proposed, and we intend to publish revised modeling in a SNPR. The strategy that we modeled as EPA216_IAQR_2003 includes a nationwide SO2 cap of 4.5 million tons in 2010 and 3.15 million tons in 2015. Since almost all of the SO2 reductions occur in the proposed region, the larger modeling region provides a good estimate of the impacts of SO2 reductions on the smaller proposed region. For NOx, the modeled region includes a similar but not identical group of eastern States to the proposal, with caps of 1.58 million tons in 2010 and 1.3 million tons in 2015. See Figure 1. This IPM run also includes the same State-specific programs as the Base Case run (EPA216_a9c).

EPA used the Proposed IAQR Case model run to analyze the impacts of the policy including the marginal costs of annual SO2 and NOx controls under the proposed IAQR. Marginal costs are presented in Tables 1 and 2 at the end of this memo. We also used parsed results from the Proposed IAQR Case run, for model years 2010 and 2015, in order to analyze State-level effects of the proposal. IPM Run ID and descriptive titles for the parsed Proposed IAQR Case runs are as follows:

IPM Run ID: EPA216_IAQR_2003_2010_parsed
Descriptive Title: Proposed IAQR Case parsed for year 2010

IPM Run ID: EPA216_IAQR_2003_2015_parsed
Descriptive Title: Proposed IAQR Case parsed for year 2015

IPM Run ID: EPA216_IAQR_NONOX_2003
Descriptive Title: Proposed IAQR SO2 Policy with Base Case NOx
This run uses the same SO2 policy (and same State-specific programs) as the Proposed IAQR Case (EPA216_IAQR_2003), but for NOx the Base Case policy is used (i.e., the NOx SIP Call requirements). As with the Proposed IAQR Case model run, modeling was based on slightly different regions than that covered by the proposal. The purpose of this model run is to evaluate the costs of the SO2 policy alone. Specifically, we compared the annual costs of the Base Case with the annual costs of this model run to get the costs of the SO2 policy alone, and we compared the annual SO2 emissions in the Base Case with the annual SO2 emissions in this model run. Using the annual costs of the proposed SO2 policy and the annual emission reductions we calculated the average costs of SO2 reductions. Results are in Table 1.

IPM Run ID: EPA216_IAQR_NOSO2_2003
Descriptive Title: Proposed IAQR NOx Policy with Base Case SO2
This run uses the same NOx policy (and same State-specific programs) as the Proposed IAQR Case (EPA216_IAQR_2003), but for SO2 the Base Case policy is used (i.e., the Title IV SO2 program). As with the Proposed IAQR Case model run, modeling was based on slightly different regions than that covered by the proposal. The purpose of this model run is to evaluate the costs of the NOx policy alone. Specifically, we compared the annual costs of the Base Case with the annual costs of this model run to get the costs of the NOx policy alone, and we compared the annual NOx emissions in the Base Case with the annual NOx emissions in this model run. Using the annual costs of the proposed NOx policy and the annual emission reductions we calculated the average costs of annual NOx reductions. Results are in Table 2.

In addition, we used this run to estimate the average cost of NOx reductions during months outside of the ozone season. That analysis is discussed further below (see the run ID EPA 216_IAQR_SUMNOX_2003). Results are in Table 2.

IPM Run ID: EPA216_IAQR_HI_G+E_2003
Descriptive Title: Proposed IAQR Using Alternate Assumptions for Natural Gas Price and Electricity Demand
We performed a sensitivity analysis to evaluate the effect of varying our assumptions about the price of natural gas and the demand for electricity under the proposed IAQR. The

EPA216_IAQR_HI_G+E_2003 model run is the same as the Proposed IAQR Case (EPA216_IAQR_2003), except that we based our natural gas price and electricity demand assumptions on information from the Energy Information Agency (EIA). The EIA assumptions involve higher natural gas prices, and an electricity growth of 1.86% a year rather than EPA's assumed growth of 1.55%. As with the Proposed IAQR Case model run, modeling was based on slightly different regions than that covered by the proposal. Marginal costs of annual SO2 and NOx control under these alternate assumptions for natural gas price and electricity demand are shown in Tables 1 and 2, respectively.

IPM Run ID: EPA216_IAQR_HI_G+E+SCR_2003
Descriptive Title: Proposed IAQR Using Alternate Assumptions for Natural Gas Price, Electricity Demand, and SCR Costs
This sensitivity analysis is identical to run EPA216_IAQR_HI_G+E_2003, but in addition to using EIA assumptions for natural gas price and electricity demand, we also used higher SCR cost assumptions (SCR capital costs were scaled up by about 60%). As with the Proposed IAQR Case model run, modeling was based on slightly different regions than that covered by the proposal. Marginal costs of annual SO2 and NOx control under these alternate assumptions for natural gas price, electricity demand and SCR costs are shown in Tables 1 and 2, respectively.

IPM Run ID: EPA216_IAQR_SUMNOX_2003
Descriptive Title: Proposed IAQR Using Base Case SO2 Policy and Proposed NOx Policy in Ozone Season Only
This run uses the same NOx control levels as the Proposed IAQR Case but imposes controls only during the ozone season. Base Case SO2 policy is used (i.e., the Title IV SO2 program). As with the Proposed IAQR Case model run, modeling was based on slightly different regions than that covered by the proposal. The purpose of this model run is to evaluate differences between NOx control costs annually and during the ozone season.

EPA used this model run to predict the marginal costs of controlling NOx emissions during the ozone season only, at the levels proposed in the IAQR. See Table 2.

We also used this model run to evaluate the average costs of ozone season NOx reductions. We compared the total costs of the Base Case with the total costs of this model run to get the costs of the proposed IAQR NOx policy (if it were applied in ozone season only). We also compared the NOx emissions in the Base Case with the NOx emissions this model run. We then used the costs of the ozone season NOx policy and the emission reductions to estimate the average cost of ozone season reductions. Results are in Table 2.

In addition, we used this run to estimate the average cost of NOx reductions during months outside of the ozone season (winter tons). We compared the NOx emissions under EPA216_IAQR_NOSO2_2003 (a run with the proposed IAQR annual NOx policy and Base Case SO2 policy; see run description above) to the NOx emissions under this run (proposed

IAQR NOx levels in ozone season only and Base Case SO2 policy) to estimate emission reductions in the winter under the proposed IAQR. Then we compared the total costs of the same two model runs, and used the difference in costs and the difference in emissions to estimate the average cost of NOx tons reduced in months outside of the ozone. Results are in Table 2.

IPM Run ID: EPA216_c5c
Descriptive Title: EPA Base Case for 2003 Analyses Using Alternate Assumptions for Natural Gas Price and Electricity Demand
This model run is identical to the EPA Base Case for 2003 Analyses run, except that we based the natural gas price and electricity demand assumptions on information from the Energy Information Agency (EIA). The EIA assumptions involve higher natural gas prices, and an electricity growth of 1.86% a year rather than EPA's assumed growth of 1.55%. These are the same natural gas price and electricity growth assumptions that were used in the IAQR sensitivity runs (see run EPA216_IAQR_HI_G+E_2003). EPA performed an economic and energy impact analysis for the proposed IAQR. As part of that analysis we evaluated the impacts of using EIA assumptions for natural gas price and electricity growth on economic and energy outcomes. In order to examine the impacts of the IAQR with EIA assumptions, it is necessary to compare it to a Base Case run made with the same EIA assumptions. Results of EPA's analysis are summarized in a memo to the docket entitled "Economic & Energy Analysis for the Proposed Interstate Air Quality Rulemaking".

IPM Run ID: EPA215_IAQR_ZOBC_2003
Descriptive Title: EPA Base Case 2003 used for Zero-Out Modeling
This is the Base Case IPM model run that was used for zero-out air quality modeling performed for the proposed IAQR. A detailed discussion of EPA's air quality modeling is provided in the IAQR preamble in section IV. This Base Case run parsed for model year 2010 was used in the air quality analysis. For the parsed run, the IPM Run ID and descriptive title are:

IPM Run ID: EPA215_IAQR_ZOBC_2003_2010_parsed
Descriptive Title: EPA Base Case 2003 used for Zero-Out Modeling parsed for year 2010

IPM Run ID: EPA216_IAQR_T4_Ratios_2003
Descriptive Title: Proposed IAQR Sensitivity with Trading Ratios for Title IV Allowances
This model run is a test sensitivity to evaluate the impact of allowing Title IV SO2 allowances for compliance with the IAQR at the specified trading ratios proposed in the rule and uses the NOx cap and region from the Proposed IAQR Case model run. For SO2, this run uses a region which included the Eastern 37 States plus DC (ND, SD, NE, KS, OK, TX, and all States Eastwards). This sensitivity allows IAQR-affected sources to use the following Title IV SO2 ratios for compliance with the IAQR: (1) pre-2010 allowances at a one-to-one ratio; (2) 2010 through 2014 allowances at a two-to-one ratio; and (3) 2015 and later allowances at a three-to-one ratio. This run incorporates an additional run year to capture the effect of SO2 banking prior

to 2010. EPA used this sensitivity to evaluate the potential impact of the trading ratios on emissions. Marginal costs of SO2 and NOx reductions under this scenario are shown in Tables 1 and 2, respectively.

Table 1 **Predicted Costs of SO2 Reductions under Proposed IAQR** **($1999/ton)**			
	2010	**2015**	**IPM Run ID**
Average Cost of Annual Control	$703	$754	EPA216_IAQR_NONOX_2003 compared to EPA216_ a9c
Marginal Cost of Annual Control	$737	$956	EPA216_IAQR_2003
Sensitivity Analysis: Marginal Cost of Annual Control, using EIA Assumptions for Natural Gas Price and Electricity Demand	$862	$1,119	EPA216_IAQR_HI_G+E_2003
Sensitivity Analysis: Marginal Cost of Annual Control, using EIA Assumptions for Natural Gas Price, Electricity Demand and SCR Costs	$861	$1,117	EPA216_IAQR_HI_G+E+SCR_2003
Marginal Cost using Trading Ratios for Title IV SO2 Allowances of two-to-one in 2010 and three-to-one in 2015	$805	$989	EPA216_IAQR_T4_Ratios_2003

Table 2 Predicted Costs of NOx Reductions under Proposed IAQR ($1999/ton)			
	2010	**2015**	**IPM Run ID**
Average Cost of Annual Control	$761	$732	EPA216_IAQR_NOSO2_2003 compared to EPA216_ a9c
Marginal Cost of Annual Control	$1,260	$1,467	EPA216_IAQR_2003
Sensitivity Analysis: Marginal Cost of Annual Control, using EIA Assumptions for Natural Gas Price and Electricity Demand	$1,321	$1,592	EPA216_IAQR_HI_G+E_2003
Sensitivity Analysis: Marginal Cost of Annual Control, using EIA Assumptions for Natural Gas Price, Electricity Demand and SCR Costs	$1,708*	$2,162*	EPA216_IAQR_HI_G+E+SCR_2003
Average Cost of Ozone Season Only Control	$1,031	$1,491	EPA216_IAQR_SUMNOX_2003 compared to EPA216_ a9c
Marginal Cost of Ozone Season Only Control	$2,155	$2,588	EPA216_IAQR_SUMNOX_2003
Average Cost of Non-Ozone Season Reductions	$698	$509	EPA216_IAQR_NOSO2_2003 compared to EPA216_IAQR_SUMNOX_2003
Marginal Cost using Trading Ratios for Title IV SO2 Allowances of two-to-one in 2010 and three-to-one in 2015	$1,198	$1,459	EPA216_IAQR_T4_Ratios_2003

* The modeled 2010 and 2015 marginal costs for this sensitivity run (using EIA assumptions for natural gas price, electricity demand and SCR costs) were reported erroneously in the proposed IAQR. The costs shown in this table are as predicted by the model run.

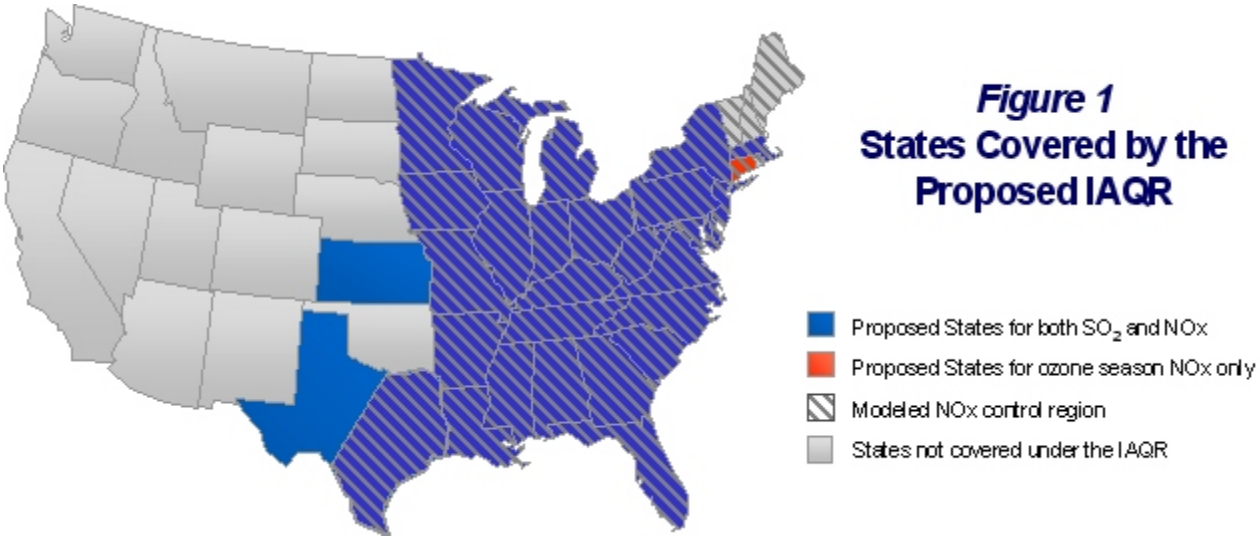

Figure 1
States Covered by the Proposed IAQR